

ALUMINUM

Project Fact Sheet



MICROWAVE-ASSISTED ELECTROLYTIC CELL

BENEFITS

- Potential to save more than \$3,726 million of energy cost annually in the U.S. beginning in 2017
- Save 107 trillion Btu of energy
- Potential to reduce 10 million tons of CO₂ emissions

APPLICATIONS

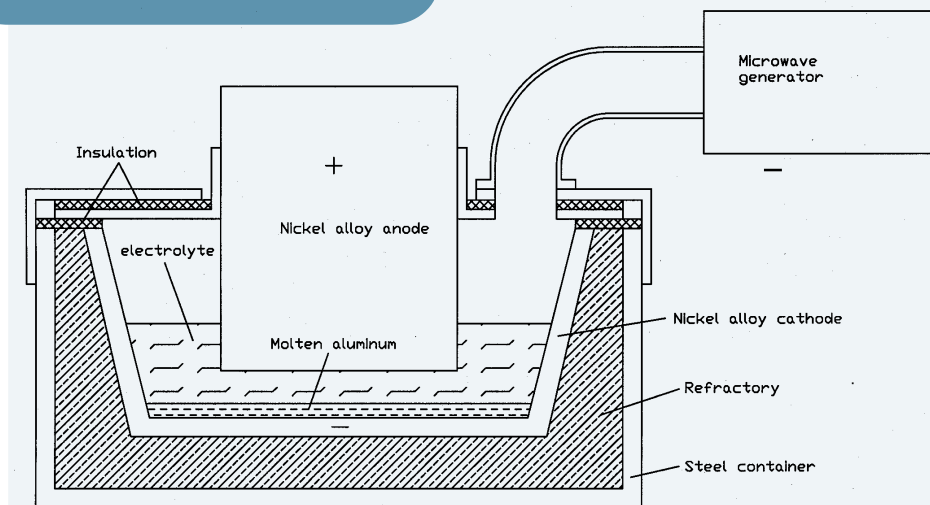
The Hall-Héroult process is used extensively to produce aluminum. This research will improve the performance of the Hall-Héroult process, reduce emissions, and conserve energy. The technology may be extended to other electrolytic processes.

MICROWAVE-ASSISTED ELECTROLYTIC CELL WITH INERT ANODE AND WETTED CATHODE FOR PRIMARY ALUMINUM PRODUCTION

All primary aluminum is produced by the electrometallurgical reduction of alumina using the Hall-Héroult process, which was invented over 100 years ago. Although many efforts have been made to advance the process, two key advancements are hindered by the operating temperatures and electrolyte chemistry of current cells. Using inert anodes and aluminum wetted cathodes can lower energy demand by 20 percent and eliminate CO₂ emissions. The current anodes and cathodes are made of carbon to satisfy the requirements for electric conductivity, salt corrosion resistance, and high temperature strength. Carbon anodes react with the oxygen discharged from alumina, and release CO₂ to the atmosphere for each kilogram of alumina produced.

This research involves developing a new electrometallurgical technology by introducing microwave radiation into the electrolytic cells for primary aluminum production. Michigan Technological University, collaborating with Cober Electronic, Inc. and Century Aluminum Company, will provide technical, economic, and energy data for evaluation of this technology by conducting bench-scale research. Controlling alumina solubility in the electrolyte is critical for low temperature operations. The proposed technology takes advantage of the microwave capability of increasing alumina solubility kinetics, so the reaction can occur at a lower operating temperature. The lower temperature provides the possibility of using a nickel-based superalloy for manufacturing the inert anode and wetted cathode. The nickel-based superalloy is inert to oxidation at 750° C, wetted with molten aluminum, and has excellent salt corrosion resistance.

ELECTROLYTE CELL



Microwave Assisted Electrolyte Cell



Project Description

Goals: The project goal is to demonstrate the potential to enhance the electrolytic bath kinetics with microwave radiation to allow the use of materials that have demonstrated good electrolytic inertness at lower temperatures. The objectives to achieve the goal are to a) design and build a bench-top microwave-assisted electrolyte cell with a selected nickel alloy anode and cathode; b) modify electrolyte chemistry; c) conduct aluminum electrowinning tests and characterize resulting products; d) generate a solid base of technical, energy, and economic data; e) evaluate opportunities and barriers; f) accumulate knowledge and experiences for the next phase of development; and g) promote student learning and training.

Progress and Milestones

The following tasks will be completed to achieve the stated goals:

- Design a microwave-assisted electrolytic cell.
- Fabricate the cell;
- Install and test the cell;
- Design several new chemistries of salt electrolyte;
- Examine the remaining electrolyte, produced aluminum, anode, and cathode after each test; and
- Establish an energy consumption model for the new electrolyte cell using standard thermodynamic data.

Commercialization Plan

Industrial participants will be involved directly with the technical, economic, and commercial development of the technology. Their participation will accelerate the technology transfer to industry and minimize the risk of commercial implementation. The most expeditious way to disseminate the complete technology package to interested parties is to license the technology. To follow this commercialization path, the university plans to seek patent protection for the new development of this technology and negotiate licensing agreements at the appropriate time.



PROJECT PARTNERS

Michigan Technological University
Houghton, MI

Century Aluminum Company
Ravenswood, WV

Cober Electronics, Inc.
South Norwalk, CT

**FOR ADDITIONAL INFORMATION,
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